ARS 42-71
OCTOBER 1962

UNITED STATES DEPARTMENT OF AGRICULTURE
Agricultural Research Service

DIFFERENTIAL HARVESTING OF COTTON

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Maturity of the cotton crop in the High Plains area of Texas and Oklahoma varies considerably from year to year; however, frost usually occurs before all of the bolls are mature.

The fiber of the cotton plant is produced in bolls. The bolls on the cotton plant are set throughout the growing season. Bolls that set late in the season do not have time to mature before frost kills the plants. Consequently, when frost occurs, there are a number of immature green bolls remaining on the plant. These bolls with immature fiber are harvested along with the mature by the once-over nonselective stripper harvester. The mixing of mature and immature fibers lowers the quality and uniformity of the entire lot. The separation and the separate handling of these immature bolls will improve the quality of the bulk of the crop and under some conditions increase overall crop value.

Presently available pneumatic separators on strippers and in ginning installations are effective in removing these immature fibers only when they are in the green boll stage. Much stripper harvesting is done after the green bolls containing immature cotton become dry and are difficult to separate with pneumatic separators.

A large percentage of the late-set bolls that are immature at the time of frost are located in the top of the cotton plant. Thus conditions are such that the top and bottom portions of the plant could be harvested separately--a process that would separate the immature bolls on the top of the plant from the older, more mature bolls on the bottom of the plant. This is known as differential harvesting.

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A study was made in 1960 and 1961 to evaluate the differential harvest technique. The objectives of this study were:

1. To determine the relative location of unopen bolls on the plant at the time of frost.
2. To determine the quality and value effects of harvesting the top and bottom crops separately.
3. To develop or adapt a stripper for differential harvesting.

PROCEDURE

The investigations were conducted during the 1960-61 harvest seasons. The procedure for each year is outlined separately.

1960

The study was made on a 0.01-acre hand-stripped plot basis to determine if the possible advantages of differential harvest would justify building or adapting a stripper for this type of harvest.

The cotton used in the investigation was irrigated Blightmaster variety, a stormproof stripper-type grown on the High Plains. The cotton was planted in 40-inch rows. Conventional cultural practices were followed in the production of the crop.

A plant study was made at the time of frost to provide information on maturity, plant height, and relative green boll location. Twenty ten-plant samples were taken at random from the differential harvest plots. Measurements were taken of plant height and of each unopen boll height on each plant.

A differential harvest level separating the bolls on the top third of the plant from the bolls on the bottom two-thirds of the plant, based on mean plant height, was selected on the basis of total and immature boll distribution found from the plant study. A cord separating the top third from the bottom two-thirds was used as a reference as the differential harvest plots were hand harvested.

One-thousand gram bur cotton samples were taken from each harvested lot for ginning. These samples were processed on a laboratory gin installation with sufficient precleaning and lint-cleaning equipment to give samples with a quality value index comparable to those from a commercial gin. The lint samples were classed for grade and staple length. Upper half mean (UHM) length, uniformity, strength, micronaire, and colorimeter measurements were also taken.

1961

The 1961 test was set up to evaluate the differential harvest principle under more varied conditions than in 1960. Blightmaster variety cotton expressing three different maturity levels or percent open at the time of frost was used in the study. These varying maturity levels were obtained by different moisture and fertility levels. The maturity levels used in the 1961 study are outlined in table 1.

Table 1. Moisture and fertility levels in the differential harvest study, Lubbock, Tex., 1961

Maturity level (percent open)1/	Moisture level	Fertility level
1. 89.3	3 summer irrigations	80# N 60# P_2O_5
2. 72.6	4 summer irrigations	80# N 60# P_2O_5
3. 42.7	Preplant irrigation + 5 summer irrigations	260# N + 15 tons manure

1/ At first frost Nov. 3, 1961.

A plant study was again made at the time of frost to provide information relative to crop maturity or percent open, plant population, plant height, immature boll location, and extent of fruiting (table 2). Six ten-plant samples were taken at random in each maturity level treatment. This information was used to evaluate the effectiveness of the differential method in separating or segregating the immature bolls.

The differential harvest treatment and a check or total harvest treatment were used in the study. The test involved three replications of each harvest treatment in each maturity level from a randomized plot layout. Plots were set up on a 0.005 acre basis. Harvesting and sampling procedures were the same as in 1960.

RESULTS

1960

The differential harvest plots were not defoliated or desiccated and were 91.1 percent open on October 31 when the first frost occurred. The high degree of maturity was further borne out by the plant character study: 68.5 percent of the plants were completely mature, 19.5 percent of the plants had only one green boll, 5.5 percent had two green bolls, and 6.5 percent had more than two green bolls. The mean plant height was 19.7 inches with standard deviation, s = 4.5 inches; the mean unopen boll height was 17.6 inches; s = 6.6 inches; and the mean height of a plant's lowest unopen boll was 15.1 inches, s = 5.5 inches.

Table 2. Mean plant character values at the time of frost for differential harvesting investigations on four crop maturity levels, Blightmaster variety, Lubbock, Tex., 1960-61

Character	1960	1961		
		Maturity level 1	Maturity level 2	Maturity level 3
Maturity.....percent open	91.1	89.3	72.6	42.7
Plant height.....inches	19.7	29.5	34.1	40.0
Unopen boll height.....inches	17.6	24.1	24.7	22.3
Lowest unopen boll height...inches	15.1	21.4	18.1	13.3
Plant population per acre...number	1/	52,000	36,000	39,000
Extent of fruiting, bolls per plant.....number	6.89	7.95	10.40	8.63
Total plant immaturity, unopen bolls per plant.....number	0.62	0.85	2.88	4.95

1/ Data not taken in 1960.

The top third of the crop in the differential harvest treatment included 34 percent of the total crop and 74 percent of the green bolls. All of the green bolls on 71.6 percent of the plants having green bolls were harvested in the top crop.

An average, weighted on the basis of yield, of the top and bottom differential harvest measurements of grade, staple length, UHM length, uniformity, strength, micronaire, and lint value indicated no significant (0.05 level) benefits attributable to differential harvesting over conventional stripper harvesting. There were no 0.05 level differences between these same measurements for the bottom of differential harvesting and conventional total stripper harvesting.

1961

The cotton was 89.3, 72.6, and 42.7 percent open in maturity levels 1, 2, and 3 respectively when the first frost occurred on November 3. No harvest-aid chemicals were used on the plots. The relative maturity of each maturity level was further indicated in that no immature bolls were present on 51.7, 18.3, and 3.3 percent of the plants in maturity levels, 1, 2, and 3 respectively. Total and immature boll distribution on the plant, figures 1 and 2, gave an indication of the effectiveness of differential harvesting in separating or segregating the immature bolls. The percent of immature

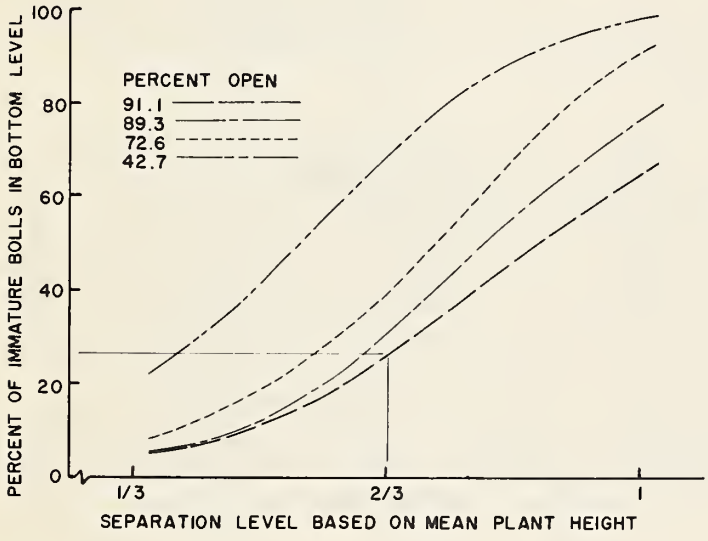

Figure 1. Immature boll distribution on the cotton plant for four maturity levels.

Example: A differential harvest treatment separating the cotton on the bottom two-thirds of the plant from that on the top one-third at a maturity level of 91.1 percent open would include 26 percent of the immature bolls in the bottom level and 74 percent of the immature bolls in the top level.

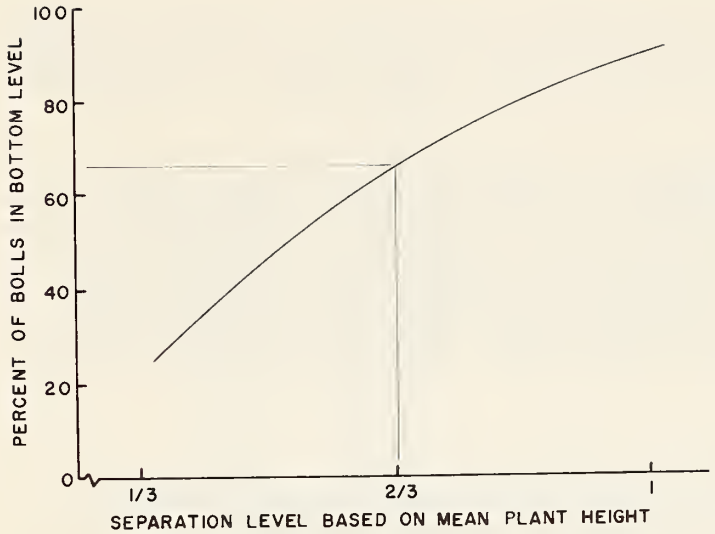

Figure 2. Total boll distribution on the cotton plant (curve derived from data in USDA Technical Bulletin No. 710).

Example: Sixty-six percent of the total bolls on the plant are located in the bottom level and 34 percent of the total bolls are located in the top level for the two-thirds bottom to one-third top separation level.

bolls in the top third of the plant was 69, 60, and 31 for maturity levels of 89.3, 72.6, and 42.7 percent open, respectively. The top third of the plant included all of the immature bolls on 58.7, 24.5, and 2.5 percent of the plants having green bolls for maturity levels 1, 2, and 3 respectively.

Measurements of grade, staple length, UHM length, uniformity, strength, micronaire, lint turnout, and lint value for differential harvesting were compared with those for conventional stripper harvesting at the 0.05 level of significance. The weighted average value of USDA grade index for differential harvest, maturity level three, was higher than that for conventional stripper harvest. However, there was no difference in a price-based grade index. The weighted average value of Pressley strength index for differential harvest, maturity level three, was higher than for conventional stripper harvest. In maturity level one, conventional stripper harvest had higher micronaire index than the weighted average for differential harvest. No other differences between the yield-weighted average for differential harvest and conventional stripper harvest or the bottom of differential harvest and conventional stripper harvest were observed.

Test data are summarized in tables 3, 4, 5, and 6.

Table 3. Differential harvest test summary, 91.1 percent open at frost, Lubbock, Tex., 1960

Measurement	Differential harvest			Conventional stripper harvest
	Top	Bottom	Weighted average	
Lint yield per acre.....pounds	279	545	824	866
USDA grade index.....	98	96.0	96	96
Classers staple length.....32d inch	31	32	32	32
UHM length.....inches	.98	.97	.97	.97
Uniformity.....	40	39	39	40
Pressley strength.....thousand p.s.i.	77.6	78.4	78.2	78.0
Micronaire index.....	4.2	4.4	4.3	4.3
Lint turnout.....percent	25.0	25.9	25.7	25.3
Lint value per pound.....cents	30.58	30.17	30.33	30.33

Table 4. Differential harvest test summary, maturity level No. 1, 89.3 percent open at frost, Lubbock, Tex., 1961

Measurement	Differential harvest			Conventional stripper harvest
	Top	Bottom	Weighted average	
Lint yield per acre.....pounds	328	625	953	858
USDA grade index.....	100	100	100	98
Price based grade index.....	32.93	32.93	32.93	32.20
Classers staple length.....32d inch	30	31	30	30
UHM length.....inches	.96	.95	.95	.92
Uniformity.....	45	44	44	44
Pressley strength.....thousand p.s.i.	70.5	70.2	70.3	70.1
Micronaire index.....	3.1	3.1	3.1	3.4
Colorimeter code.....	619	619	619	635
Lint turnout.....percent	23.7	22.7	23.0	22.3
Lint value per pound.....cents	31.38	31.91	31.65	30.68

Table 5. Differential harvest test summary, maturity level No. 2, 72.6 percent open at frost, Lubbock, Tex., 1961

Measurement	Differential harvest			Conventional stripper harvest
	Top	Bottom	Weighted average	
Lint yield per acre.....pounds	342	791	1038	858
USDA grade index.....	100	100	100	100
Price based grade index.....	32.93	32.93	32.93	32.93
Classers staple length.....32d inch	30	30	30	30
UHM length.....inches	.93	.97	.96	.95
Uniformity.....	44	43	43	43
Pressley strength.....thousand p.s.i.	69.8	67.5	68.2	66.8
Micronaire index.....	2.8	3.3	3.1	3.2
Colorimeter code.....	602	602	602	602
Lint turnout.....percent	21.8	22.2	21.8	21.8
Lint value per pound.....cents	31.11	31.65	31.49	31.65

Table 6. Differential harvest test summary, maturity level No. 3, 42.7 percent open at frost, Lubbock, Tex., 1961

Measurement	Differential harvest			Conventional stripper harvest
	Top	Bottom	Weighted average	
Lint yield per acre.....pounds	273	484	757	760
USDA grade index.....	100	99	100	98
Price based grade index.....	28.56	30.06	29.45	28.35
Classers staple length.....32d inch	29	29	29	29
UHM length.....inches	.93	.95	.95	.93
Uniformity.....	43	42	42	42
Pressley strength.....thousand p.s.i.	67.5	68.7	68.2	67.0
Micronaire index.....	2.5	2.7	2.6	2.6
Colorimeter code.....	520	519	519	504
Lint turnout.....percent	19.1	20.9	20.2	20.0
Lint value per pound.....cents	26.31	28.16	27.41	26.13

DISCUSSION AND CONCLUSIONS

The 1960 test gave credence to the original idea that a large percentage of the bolls remaining immature at the time of frost were located in the top portion of the plant. Under these conditions, differential harvesting separated a high percentage of the immature bolls into one group. Yet, there was enough mature cotton in the immature boll group to almost nullify the benefits of the separation. The 1961 study covered a wider range of crop maturity, and indicated that the lower the maturity--the lower the percentage of immature bolls in the top portion of the plant. These conditions are not favorable to a differential method of harvest. The separation of the immature cotton from the mature is more desirable from the standpoint of quality maintenance when there is a relatively high percentage of immature bolls. Differential harvesting is not an effective means of separation under these conditions.

The change in immature boll distribution for the various maturity levels indicates that different separation levels for different maturity levels or a separation level other than the one used in these tests may be more effective in segregating the immature bolls into one group. The most effective separation level would divide the plant at the point of maximum immature bolls in the top of the plant and maximum mature bolls in the bottom of the plant. The distributions in figures 1 and 2 indicate that any separation level is a compromise. The spread between the total crop curve and the immature crop curves for the three higher maturity levels is greater around the two-thirds separation level. This occurs at a point on the plant above the majority of the total crop, therefore, more closely reaching the most effective separation level than any other.

A very high percentage of the immature bolls and a low percentage of the mature bolls located in the top portion of the plant would be an ideal condition for differential harvesting. These tests indicate that this condition would not be approached sufficiently with present cotton varieties and cultural methods to make differential harvesting feasible.

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